REMARKS

A. Specification

The disclosure has been objected to due to an informality on page 13, line 15. The specification has been amended to correct the informality in the manner suggested by the Examiner. In addition, the specification has been amended to correct two other clerical errors.

B. Claim Rejections - 35 U.S.C. § 102

1. Status of Claims

Claims 1-22 have been rejected under 35 U.S.C. § 102(e) over U.S. Publication No. 2004/0005089 to Robles. Independent claims 1 and 15 have been amended to more clearly recite that which the Applicant regards as the invention. Dependent claims 2 and 16 have been canceled for consistency with the amendments to the base claims. Dependent claims 3-4, 13-14, 17-18 and 21-22 have been amended to more clearly recite that which the Applicant regards as the invention.

2. Introduction

The claims patentability define over the prior art since the claims recite a novel and unobvious technique for conducting optical proximity correction (OPC) whereas Robles applies pre-OPC simulation resolution enhancement techniques (RETs) to a layout and then conducts a conventional OPC simulation on the RET modified layout.

3. Overview of Claimed Invention

Claimed is a method of carrying out optical proximity correction, or OPC, that differs from conventional forms of OPC. Conventional OPC is concerned with improving imaged pattern fidelity by moving edges or fragments of edges of the reticle pattern that will be used to project the imaged pattern (page 2, lines 7-16). Conventional OPC is carried out to attain the highest degree of image correction quality possible. Accordingly, prior to the claimed invention, edge placement error (EPE) has

been used as the benchmark to gauge how well the OPC has corrected the image (page 2, line 16-32).

The Applicant has come to realize that conventional OPC itself can cause instability in the corrected pattern in the sense that the imaging of some corrected features can be so sensitive to process factors that the projected version of the feature can unpredictably shift to an unacceptable location (page 3, lines 1-30). Process factors, of course, relate to characteristics of the actual imaging process (such as focus, exposure dose or other illumination condition) and not assumptions made during a pre-reticle fabrication pattern correction process.

In some cases, the Applicant found that the sensitivity of conventionally corrected patterns can be so extreme that even process factor changes that are within an accepted tolerance level for the process factor can cause unpredictable imaging of the unstable feature. As an example, even if focus of the imaging optics is in tolerance, a feature made unstable by the OPC manipulations to changes in focus can be imaged in an unpredictable and/or unacceptable manner.

To address this issue, Applicant invented a technique to make the output of the OPC process more forgiving to the imaging process - even at the risk of generating a more distorted image than would occur with conventionally corrected images (see, for example, page 13, line 22 to page 14, line 2) and introducing complexities to OPC that may result in longer simulation times.

In the claimed invention, the conventional pattern fidelity convergence benchmark is a general figure of merit (GFOM) that is derived from plural individual figures of merits associated with the corrected layout. Further, each individual figure of merit is based on a different process metric. Specifically, after an edge segment manipulation (e.g., OPC iteration), the simulation generates the individual figures of merit and then the GFOM from the individual values. Then, the corrected version of the layout is re-manipulated using the GFOM to assist in optimizing local critical dimension (CD) accuracy. The introduction of plural quantifiable metrics (see, e.g., page 5, lines 11-16) into the OPC, but as a consolidated GFOM value, advantageously leads to an

advantageously leads to an acceptable level of image correction quality while desensitizing the corrected layout to process factors (see, also, page 16, lines 14-22).

The prior art of record does not teach or reasonably suggest the claimed approach for carrying out OPC.

4. Deficiencies in the Applied Art

Robles fails to disclose a method of conducting OPC using a GFOM that has been derived from plural individual figures of merit as a convergence benchmark. Rather, Robles teaches conducting various pre-OPC simulation RETs to improve image contrast and then conducting conventional OPC that converges to a solution dictated by pattern fidelity alone. Also, Robles' histograms are not plural individual figures of merit from a layout corrected by OPC, Robles' cost function is not a GFOM and Robles' OPC does not disclose anything other than a conventional OPC process.

Robles explains that "traditional model-based OPC techniques improve the overall pattern fidelity of a lithographic image by minimizing edge placement errors" (para. 0106). Although Robles discloses improving contrast of the pattern before OPC is performed (para. 106, last sentence), there is no indication that the OPC approach itself is changed.

The teaching portion of Robles, or the "Detailed Description" section, is essentially broken into two parts. The first part spans paragraphs 0052 to 0103 and discloses the general operating concept of Robles' techniques. The second part spans paragraphs 0104 to 0164 and is directed to implementable embodiments of the general operating concept set forth in the first section.

Accordingly, once an understanding of the first section of Robles is made, then it will be apparent that Robles, and in particular the compilation of paragraphs cited by the Examiner, does not teach or reasonably suggest the claimed invention. Robles applies pre-OPC RETs (e.g., SRAF, adjustments for off-axis illumination, adjustments for di-pole illumination, adjustments for phase shift masks, etc.) to modify the contrast of projected edges (paras. 00057 and 0058). Robles indicates that SRAF may be

conducted as a rules-based OPC technique. However, in every instance where Robles describes the use of SRAF, SRAF is conducted solely with the aim of improving contrast before OPC is used to address image fidelity. In the claimed invention, OPC is used to optimize CD accuracy. Therefore, for purposes of applying Robles' SRAF as being potentially instructive of features of the claims, it is appropriate to consider Robles' SRAF in the group of pre-OPC RETs used to modify contrast of projected edges and not as part of an OPC technique to optimize CD accuracy.

During these pre-OPC adjustments, Robles sharpens the intensity profile of the desired image (i.e., improves contrast, which is indicated by the image's intensity profile and can be quantified using image log slope (ILS), for example). Once a contrast improved pattern is generated by Robles, then conventional OPC is applied (para. 0057, last sentence). While Robles contends that the OPC does not need to move edges as far as would be done without the contrast improving pre-OPC adjustment, there is no indication that the OPC routine itself is based on anything other than edge placement.

Since the possible pre-OPC RETs to improve image contrast each include a variety of selectable variables (or "resolution enhancement variable") and one RET to another has different contrast enhancing results, Robles sets forth a scheme for selecting a best RET and best variables for that RET to apply. Referring to figures 5a-5e and paragraphs 0060 to 0087, Robles approach is to try each RET and each RET variable and generate histograms for each permutation. These histograms are merely plots of the number of edge fragments in each of plural predefined contrast classifications as defined by corresponding contrast ranges (see, paras. 0063 to 0068). These histograms are used to help select the "best" RET and RET variables to improve contrast of particular edges using intermediately generated cost curves (paras. 0069 to 0084). After applying the selected RET and RET value(s) (para. 0076), Roble's process continues to test if the contrast of the original design is improved by the modifications (paras. 0085 to 0087).

Only after all of the foregoing, does Robles carry out OPC as shown in the very last block 536 of figure 5E and tersely explained at paragraph 0088. As is apparent, Robles' histograms are not plural individual figures of merit from a layout corrected by OPC or that each correspond to a different process metric. Also apparent is that Robles' cost function is not a GFOM. Perhaps most importantly, Robles' OPC does not disclose anything other than a conventional OPC process.

The second section of Robles' disclosure only reinforces that which is learned from the first section. In this section, Robles explicitly states that "traditional model-based OPC techniques improve the overall pattern fidelity of a lithographic image by minimizing edge placement errors" and offers only to improve the contrast of the pattern before executing the conventional OPC simulation (para. 0106).

Paragraphs 0111 and 0112 of Robles are cited by the Examiner as teaching generating plural individual figures of merit for a pattern corrected by OPC. As indicated above, this is not correct. What is stated in these paragraphs is that before OPC is performed, the pattern is optimized based on ILS, or contrast, to get the pattern ready for OPC. Then, conventional OPC is used to attain a target CD. The generation of histograms to characterize contrast for various pre-OPC RETs is discussed in paragraphs 0118 to 0122.

Paragraphs 0123 to 0128 of Robles are cited by the Examiner as teaching generation of a GFOM from plural individual figures of merit for a pattern corrected by OPC. As indicated above, this is not correct. Explained in the cited paragraphs is a technique to maximize contrast by considering intersecting RET "recipes" (para. 0127). Robles explicitly states that "more importantly, after maximizing contrast, there are very few locations that have the correct placement after imaging. In order to address the final pattern fidelity of the design, a model-based OPC treatment is used" (para. 0127, emphasis added). Although Robles describes "a combination of contrast optimization and model-based OPC" (para. 0128), it is clear that the contrast optimization based on various cost curves is not performed as part of OPC, but as a precursor to OPC.

Even if one somehow were to consider Robles' optimization of the contrast (ILS) using a pre-OPC RET as being based on a first individual figure of merit and the subsequent optimization of image fidelity (EPE) using conventional OPC as being based on a second individual figure or merit, the claimed invention does not result. In particular, there is no generation of a GFOM based on plural metrics that is used to drive the OPC edge segment manipulations and completely unmotivated modifications to the teachings of Robles would be required to implement the claimed invention.

5. Patentability of Claims

Independent claim 1 is allowable for at least the reasons explained. Claims 3-14 depend from claim 1 and are allowable for at least the same reasons. In addition, each of the dependent claims recite features not taught or suggest by the prior art. For instance, claim 9 bases the GFOM on depth of focus as one of the metrics and claim 11 bases the GFOM on fragmentation complexity as one of the metrics. While these are respectively recognized by Robles as a RET implementation variable and a practical consideration for carrying out simulated exercises, neither are used by Robles to establish an OPC benchmark.

As another example, claim 13 recites that the OPC process is iterated until the GFOM value itself indicates convergence. Although Robles looks for improvements in contrast resulting from the pre-OPC RETs compared to the unmodified layout (e.g., para. 0087 cited by the Examiner), Robles does not disclose use of a GFOM that plays a contributing role in indicating a degree of pattern fidelity convergence that would end an OPC routine.

Independent claim 15 is allowable for the at least the reasons explained. Claims 17-22 depend from claim 15 and are allowable for at least the same reasons. In addition, the dependent claims recite features not taught or suggest by the prior art. For instance, similar to claim 13, claim 21 recites that the OPC process is iterated until the GFOM value indicates convergence.

C. New Claims

Claims 23-24 have been added to recite additional novel and unobvious features of the invention.

D. Conclusion

In light of the foregoing, it is respectfully submitted that the present application is in condition for allowance and notice to that effect is hereby requested. If it is determined that the application is not in condition for allowance, the Examiner is invited to initiate a telephone interview with the undersigned representative to expedite prosecution of the present application.

If there are any fees resulting from this communication, please charge same to our Deposit Account No. 18-0988, our Order No. H1788.

Respectfully submitted,

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